

Permit Review 4

LARSON ENTERPRISES, INC., SWAMP POODLE MINE (PERMIT # 17950115)

Site Summary

The Larson Enterprises Inc. Swamp Poodle Mine was an active surface mine located in Morris, Graham, and Cooper Townships, Clearfield County, Pennsylvania in the Moshannon – Mosquito Creek Priority Watershed 8D. Approximately 214,090 tons of FBC ash was placed on 50.1 acres at the Swamp Poodle mine, contemporaneous with surface mining operations. This precise amount of ash was confirmed by a letter dated April 19, 1999 from Larsen Enterprises to the PADEP. The FBC ash came from the Piney Creek Project (a waste coal facility) located in Clarion, Pennsylvania. Six coal seams were surface mined at this site, and some abandoned deep mine workings were daylighted. Four groundwater-monitoring wells were drilled and all of them are discussed in this report. The total area of the site was not specified in the permit.

The permit for this operation was issued in February 1996, with ash placement and coal mining activity starting in that month. Mining and ash placement ceased in April 1999 and the latest monitoring data in the permit file were collected in September, 1999. The final inspection and bond release occurred on May 3, 2004. The ash was placed on the site ostensibly as an alkaline addition to remediate acid mine drainage.

Geology

The six coal beds mined at the Swamp Poodle site are (from lowest and oldest, to highest and youngest) the Lower Kittanning Coals # 3 and #4, the Middle Kittanning Coals #1, #2, and #3, and the Upper Kittanning Coal. The structure of the sedimentary beds is a gentle dip (slope) to the southeast, which most likely is an indication of the original geometry of the depositional basin. The Lower Kittanning #3 Coal seam is the thickest and was deep mined prior to surface mining operations. This coal seam was deposited under marine and brackish swamp conditions, with a resulting high sulfur content that contributes greatly to AMD problems.

Topography

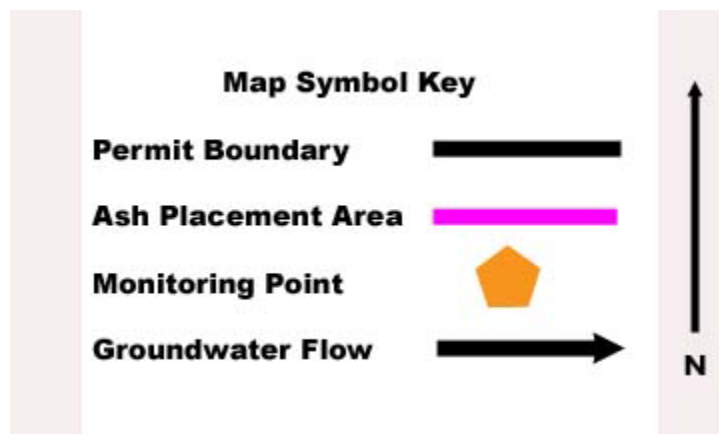
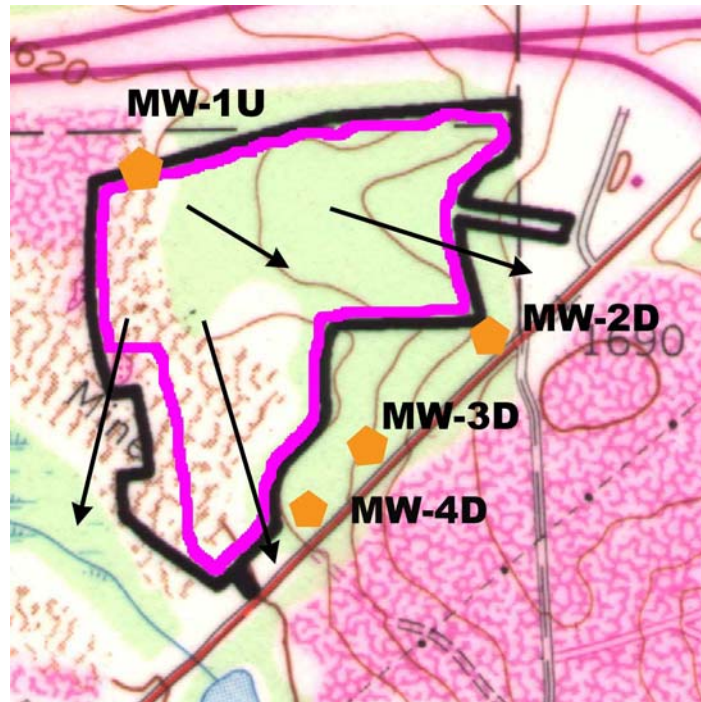
The Swamp Poodle site is located in the Pittsburgh Low Plateau physiographic province of Pennsylvania (figure 1). The site area is on the northwest side of a low, flat-topped hill (see map below), and the relief is slight; the highest elevation is 1680 feet above sea level, and the lowest is about 1590 feet. The north side of the mine is bounded by the I-80 highway.

Groundwater

The surface water and shallow groundwater flows off the hill to the north, west, and south. The east side of the site is a slight incline. Surface drainage is poor, especially

towards the west and south where there is a swamp that is drained by Flat Run. The deeper groundwater that is the focus of this report is drained by the abandoned underground coal mine in the Lower Kittanning #3 Coal. Unlike other sites studied in this project, this water follows the rock structure flowing in a different direction than the surface and shallow groundwater down the dip towards the southeast exiting the site underground and ending up in Sulfur Run, (not shown on

Site Map: Swamp Poodle



**Larson Enterprises, Inc. Swamp Poodle Operation (Permit # 17950115)
Scale: 1" = Approximately 700'**

map), a small stream southeast of the mine. Some portions of the underground mine have been daylighted. The Lower Kittanning 3 Coal elevation represents the base flow for the site. Base flow is the lowest elevation that local groundwater flows occupy when leaving the site boundaries.

Groundwater Monitoring Data: Discussion

The four monitoring wells drilled on the Swamp Poodle property are MW-1U (upgradient), MW-2D (downgradient), -MW-3D (downgradient), and MW-4D (downgradient). MW1-U sampled water from the mine pool that was already somewhat degraded from past deep mining but which is located upgradient of the area affected by the surface mining and ash placement in this permit. (MW-2D sampled the degraded mine pool water that should have additionally been affected by this permit's activities, and MW-3D sampled more diluted mine pool water that should also have been affected by this permit's activities. MW-4D sampled more diluted mine pool water also although its concentrations appear more diluted than MW-3D. All four of these wells were drilled slightly below the level of the Lower Kittanning #3 Coal into the underground workings of this seam. Analysis of the permit's coal structure map and information provided in Module 25 of the permit confirms the upgradient and downgradient positions of these wells. MW-1U is at the northwest corner of the site while MW-2D, MW-3D, and MW-4D are on the southeast edge of the mine. The wells were screened in the solid coal pillars in the underground workings as pointed out in the Module 8 Addendum, page 8-6G, of the permit. As the coal has many joints, its permeability is high, and thus the presumption is that water collected from these wells will reveal the quality of surrounding minepool water. However given the contrasting hydraulic conductivity between the coal pillar and the minepool and presumed increased residence times of water in the pillars versus the rapid turnover experienced in some mine pools, it would have been preferable to see data demonstrating the same quality which was not available in the permit file.

MW-1U

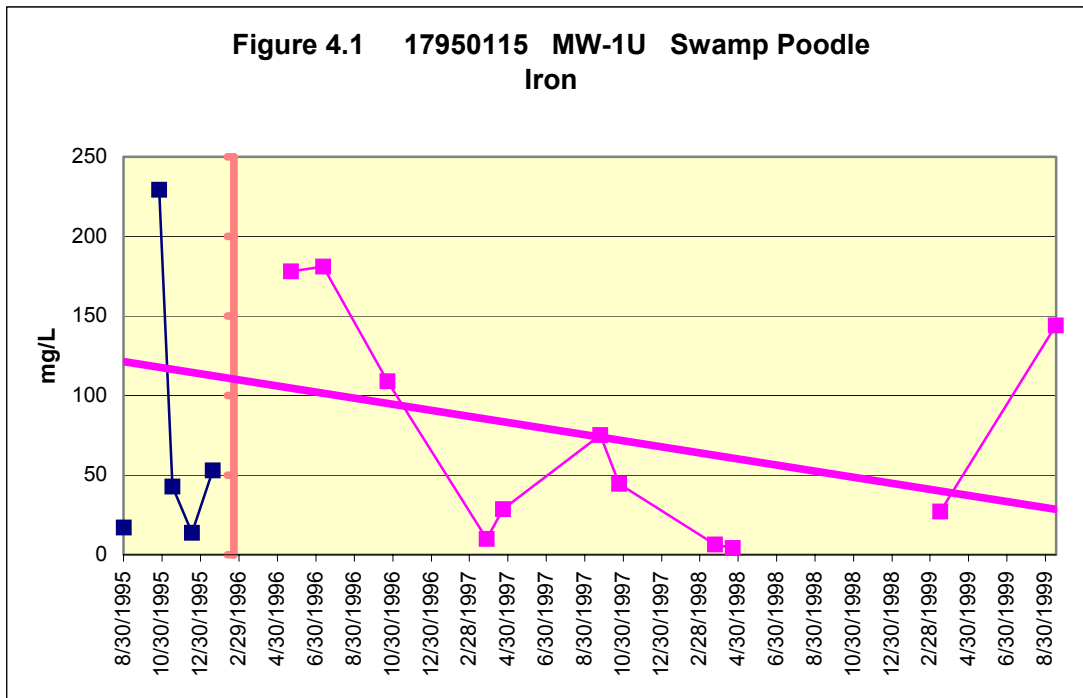
The major elements iron, manganese, and sulfate are graphed for MW-1U in figures 4.1, 4.2, and 4.3 respectively. The 1995 data points represent baseline values. Compared to other coal mine monitoring data in western Pennsylvania, these values are extremely high, except for manganese. Iron (figure 4.1) generally decreased from a high of 230 mg/L during the baseline monitoring period, which is over 750 times the PA Act 2 criteria and the federal secondary MCL for drinking water (hereafter the drinking water standard or DWS) of 0.3 mg/L. Some data for 1998 was not collected due to dry conditions.

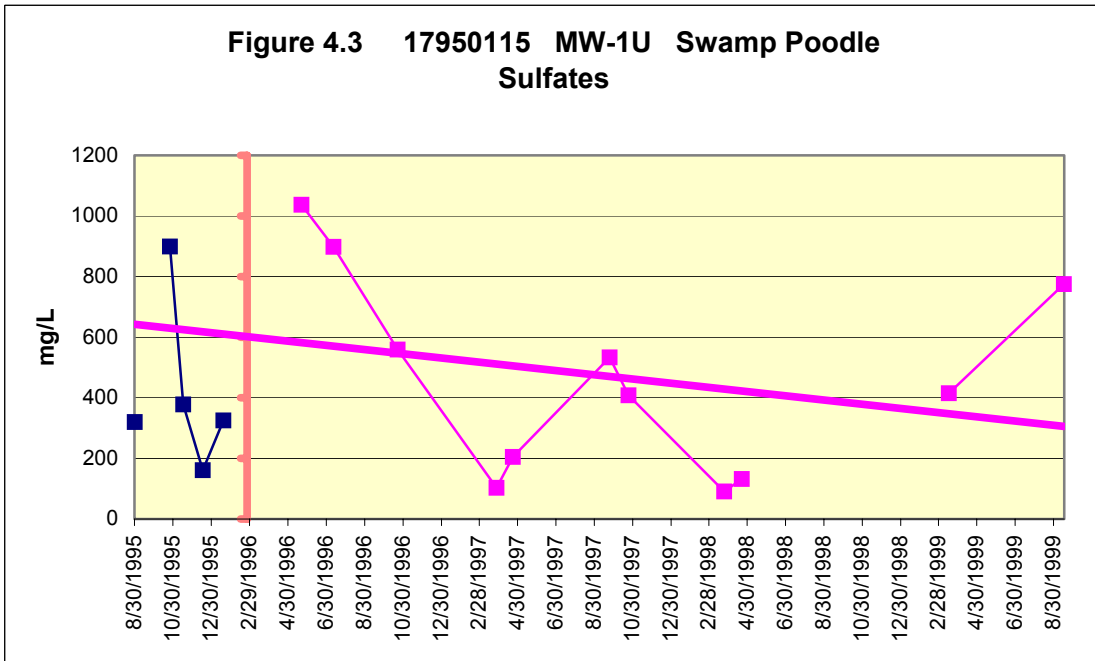
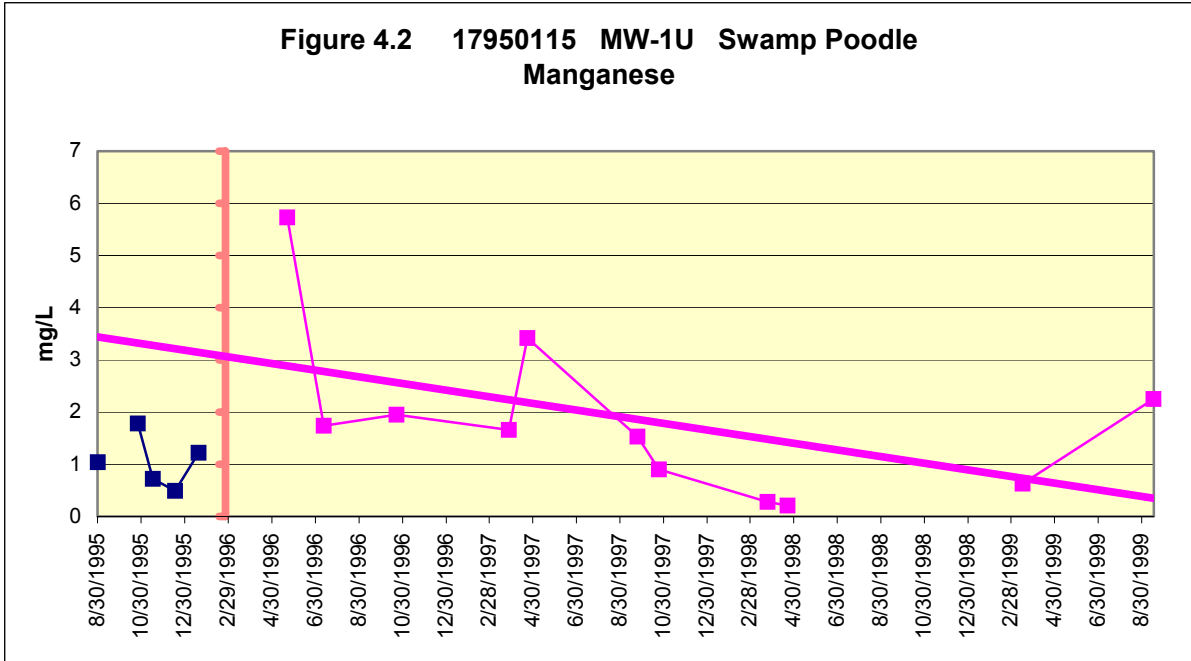
Manganese (figure 4.2) fluctuated with a high value of almost 6 mg/L, 120 times the DWS, measured in the spring of 1996 after mining and ash placement had begun followed by a decreasing trend in concentration. Sulfate (figure 4.3) was high for an upgradient well, but declined with concentrations fluctuating from over 1000 mg/L (4 times the DWS) to about 100 mg/L. The trends are downward, although for all three of

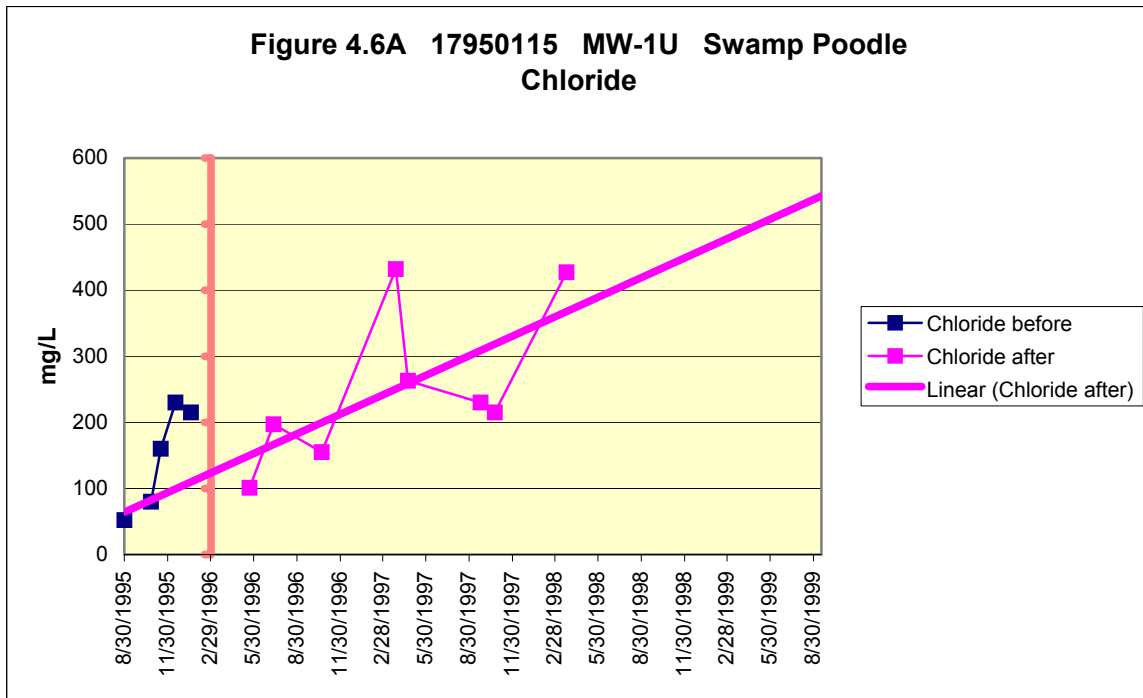
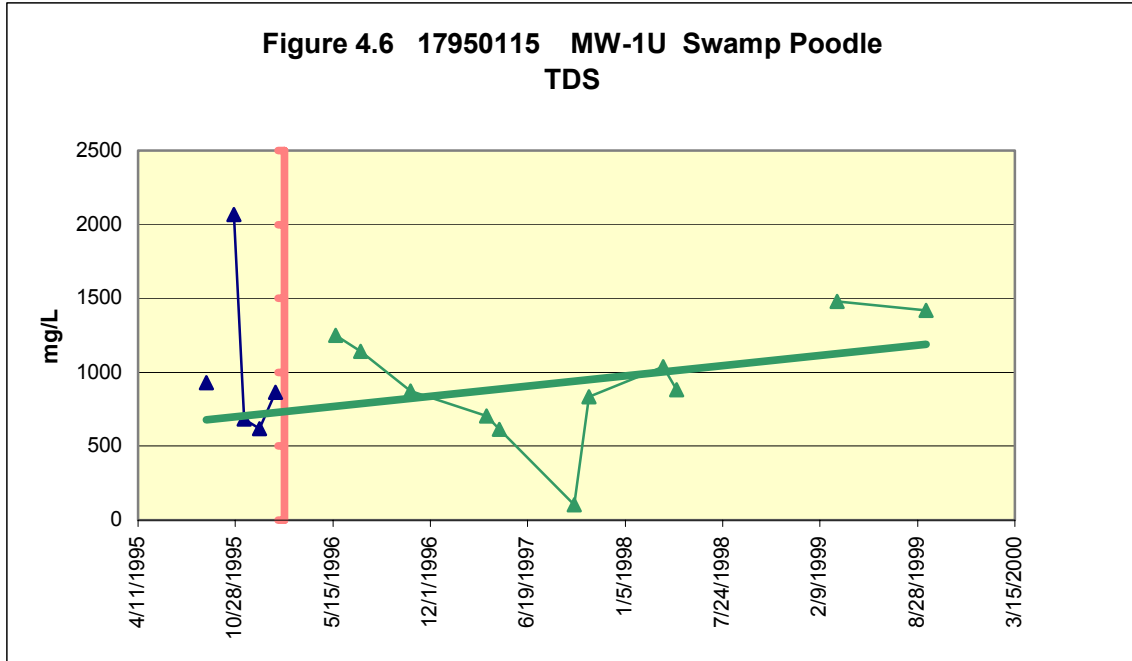
these constituents, concentrations increased in the last sampling taken in September 1999. Nonetheless despite its location within a previously mined spoil area, MW-1U’s results should portray groundwater in an area of the site that is not disturbed by the surface mining or ash placement under the permit.

The acidity value trend is declining and close to that of sulfates, indicating that weathering of sulfide minerals is the main contributor to acid conditions (figure 4.4). The pH shows a very slight downward trend, with the average being about 3.1 (figure 4.5). The trend lines for both pH and acidity are derived from concentrations measured after ash placement. The alkalinity values (not plotted) are below the practical detection limits of the measuring instrument.

Unlike other parameters the chloride concentrations rose 3 to 8 times from baseline values over the monitoring period (figure 4.6A), and total dissolved solids (TDS) also increased (figure 4.6). The permit authors attribute the rising chloride to road salt, which appears to be the most probable source of chloride, due to the site’s proximity to Interstate Route 80 on the northern border, an interchange on I-80 adjacent to the site’s northeast corner, and State Route 53 on the southeast border of the site.







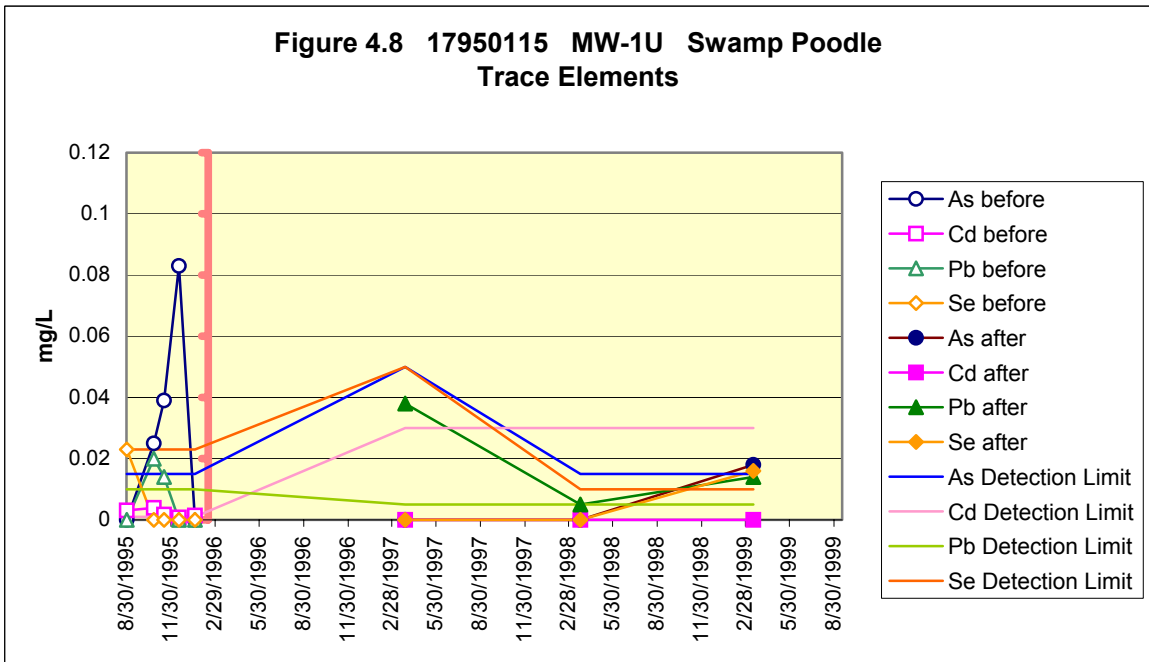
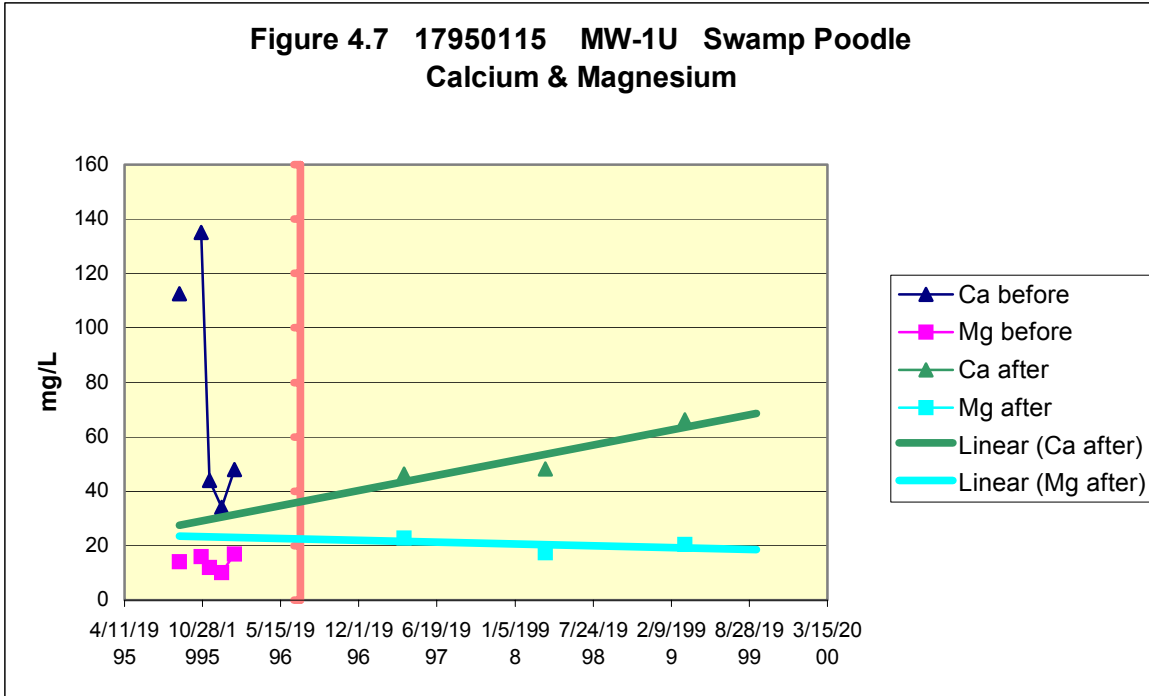
While the two highest calcium concentrations were measured during the baseline period, calcium values appear to have undergone rising trends after baseline monitoring, and magnesium values were also slightly higher after baseline monitoring (figure 4.7) at MW-1U. However there were only three annual samplings during the ash placement

period for these two constituents making assessment difficult. Thus these concentrations of calcium and magnesium may not reflect much more than negligible changes from baseline levels.

Notwithstanding this question, the levels of magnesium and calcium at MW-1U are lower than magnesium and calcium levels measured at the downgradient points implying an added source for these constituents across the site. The permit states that there are no calcareous overburden rocks at the site. The FBC ash is likely a ready, soluble source of these constituents.

Although elevated in some instances, dissolved concentrations of trace elements at MW-1U (arsenic, cadmium, lead, and selenium) (figure 4.8) were never above 0.1 mg/L. Many of the trace element concentrations are reported below detection levels. Arsenic fluctuates above and below detection levels with a high concentration of 0.0830 mg/L measured during the baseline period; selenium is below detection levels in all measurements after the first one during baseline monitoring, and is measured at a concentration of 0.016 mg/L only in March 1999 during ash placement. Cadmium is measured at levels below the DWS during the baseline period. However because the detection level for cadmium was raised after the baseline period to <0.030 mg/L, six times the DWS, it is not possible to determine whether cadmium increased to levels of concern during ash placement. Lead is measured above and below baseline concentrations with its highest value reaching 0.038 mg/L in March 1997 more than a year after mining and ash placement had begun. As with the data for the major elements, these data appear to reflect groundwater that was not affected by ash placement.

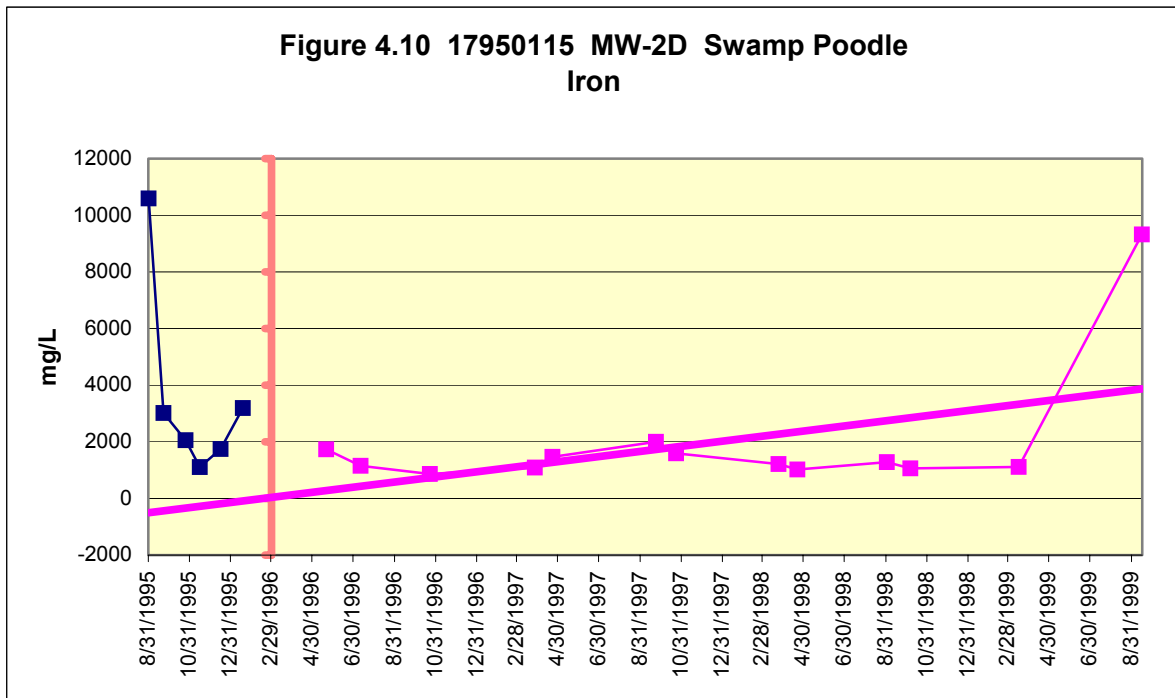
At all monitoring points, the discussion and graphing of trace element concentrations in this assessment focuses on dissolved values only. In some cases, total values were considerably higher.

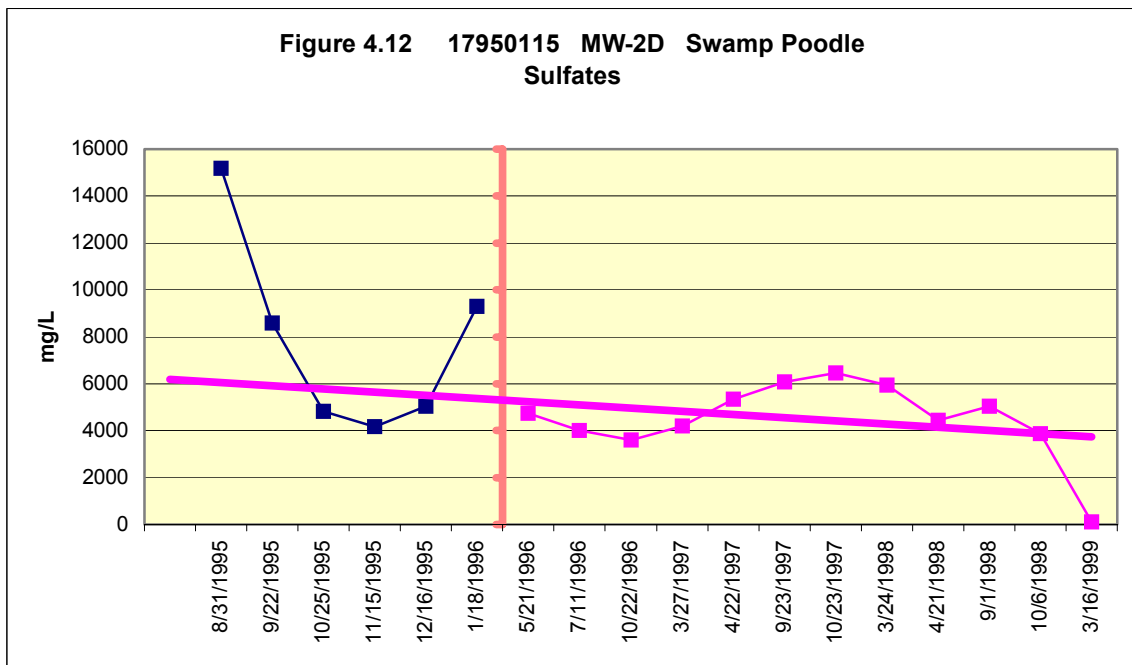
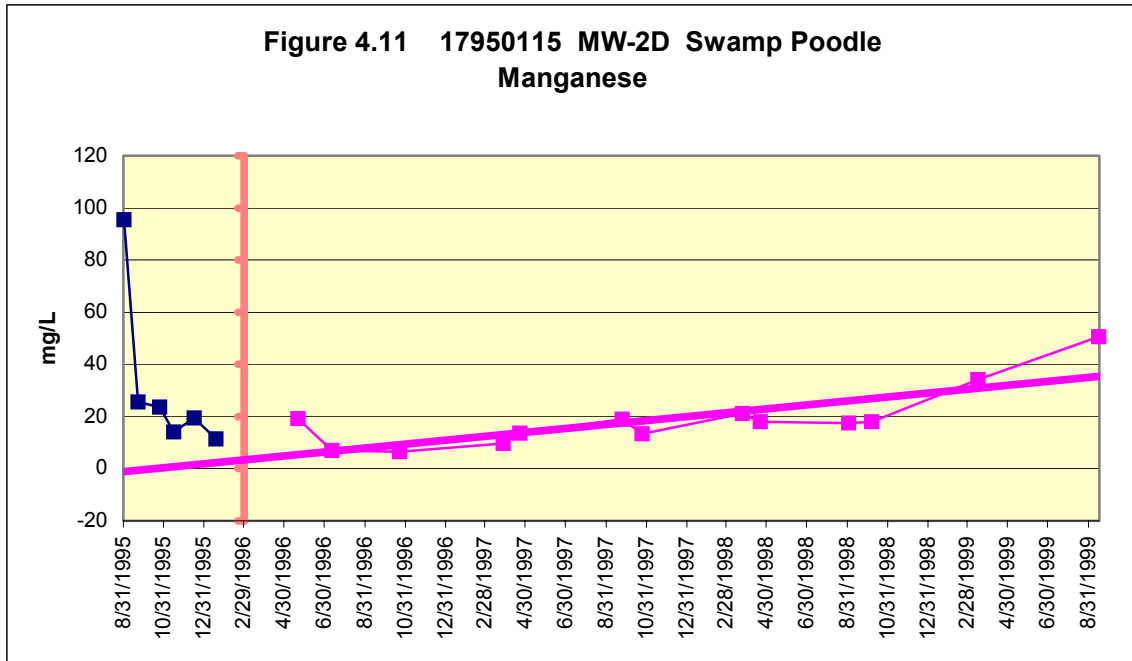


MW-2D

Major element data for downgradient MW-2D (figures 4.10, 4.11, and 4.12) show extremely high concentrations of iron, manganese, and sulfate. The DWS for iron, manganese, and sulfate are 0.3 mg/L, 0.05 mg/L, and 250 mg/L respectively. The trends for iron and manganese match generally, with baseline iron values starting at over 10,000 mg/L and the highest manganese baseline concentration at almost 100 mg/L. Iron “settles down” to between 1000 and 2000 mg/L, and manganese to between 6 and 22 mg/L. Then at the end of the sampling period, iron rises to 9320 mg/L in September 1999 and manganese rises to 50.7 mg/L. One thousand mg/L iron is over 3000 times the DWS for iron, and 50.7 mg/L is 1014 times the DWS for manganese.

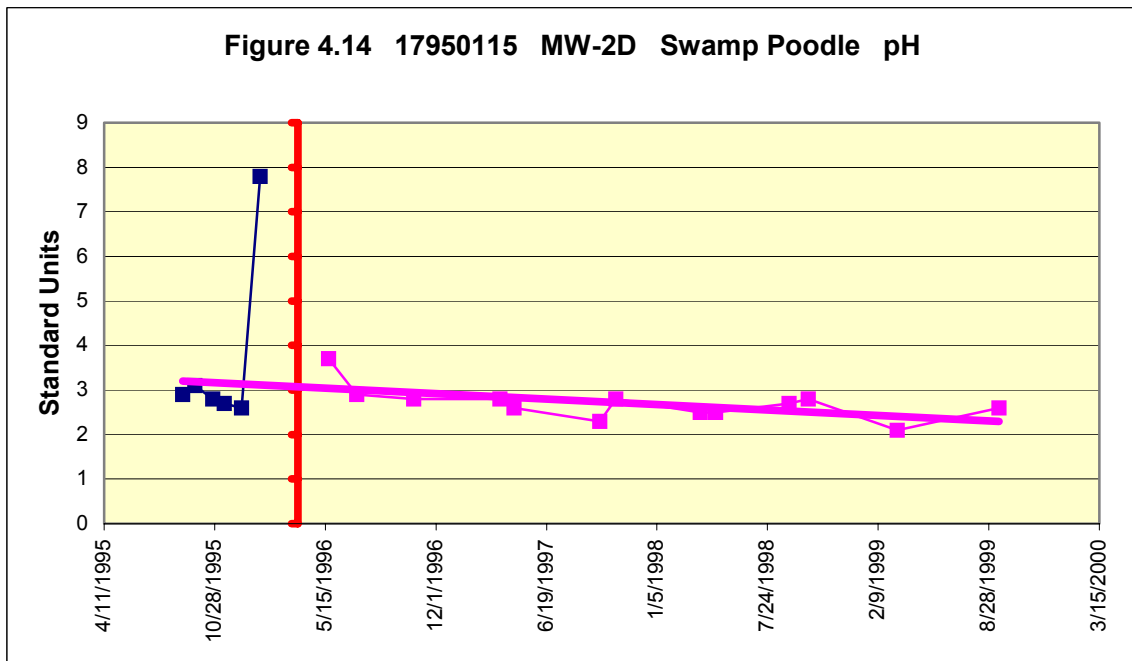
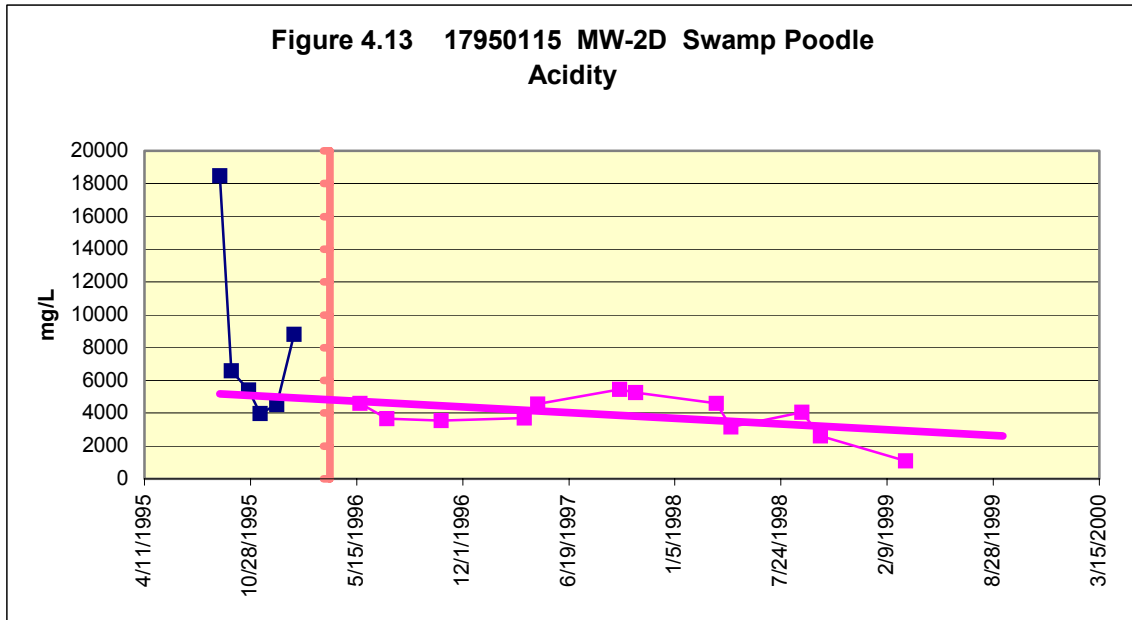
Sulfates (figure 4.12) start at 15,192 mg/L, fluctuate somewhat, and then show a downward trend averaging in the 5000 mg/L range before falling to 99 mg/L in the last sampling in March 1999. Sulfate concentrations of 5000 mg/L are 20 times the DWS. This major element data indicates severely degraded groundwater. This well, according to the permit description, is monitoring raw, undiluted mine pool water downgradient from the mining and ash placement.

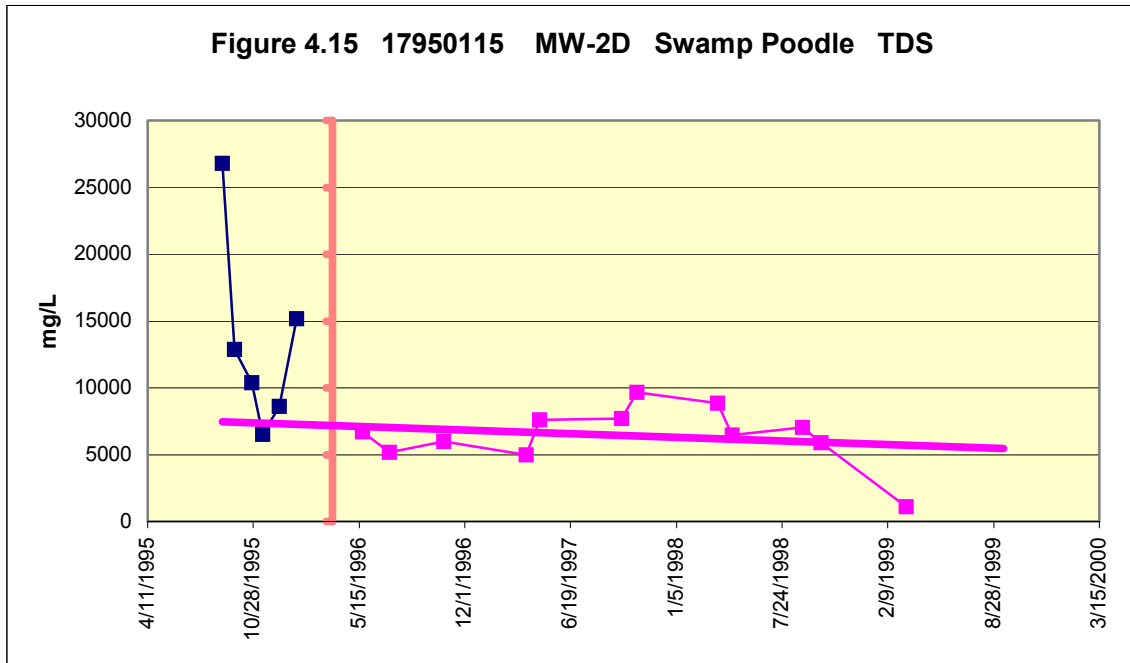




The acidity concentration trend (figure 4.13) at MW-2D drops after mining and ash placement begin and is close to the trend of sulfates, as was the case at MW-1U. The field pH (figure 4.14) shows a more modest downward trend from an average of 3 down to 2.3, with one “spike” of 7.8 in January 1996. The alkalinity is below instrument

detection limits. TDS (figure 4.15) follows the sulfate trends, suggesting that sulfates are the main contributors to the dissolved constituents leaving the site, given the sulfate concentrations are in the same magnitude as TDS concentrations.

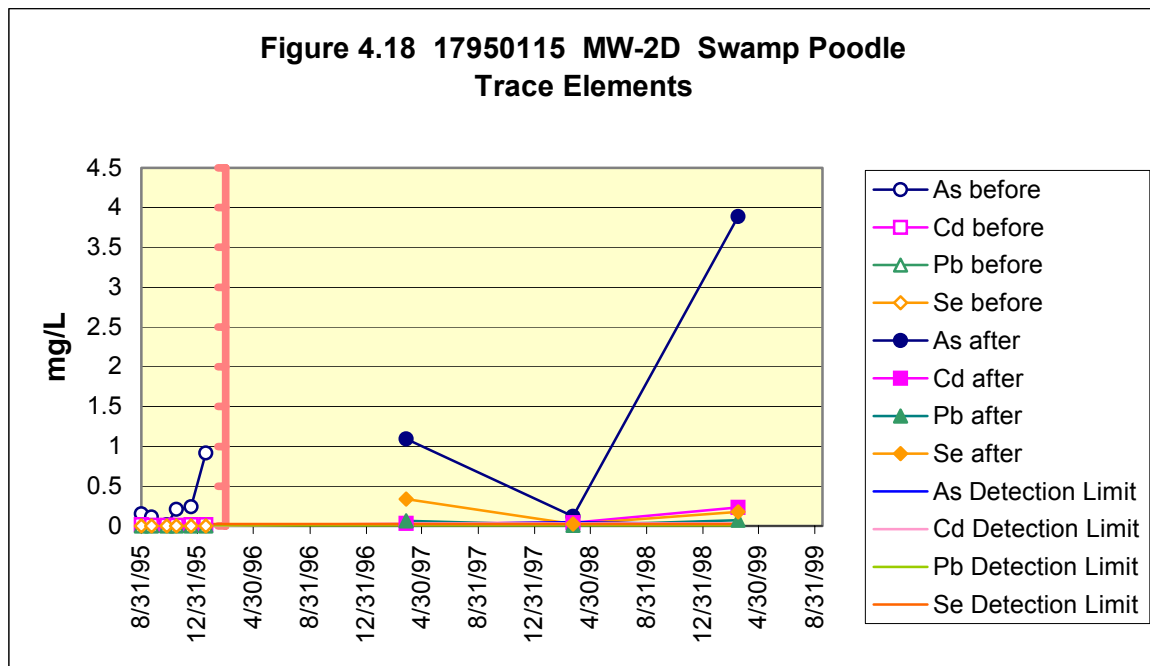




Chloride (figure 4.16) and magnesium (figure 4.17) have trends sloping upward at MW-2D, with chloride exceeding the DWS of 250 mg/L in the fall of 1997. A large anomalous spike of 2400 mg/L occurs in December, 1995.

Calcium concentrations (figure 4.17) have a downward sloping trend. The calcium values after ash placement are equal to or slightly below baseline values. The magnesium averages are slightly higher than baseline concentrations. As at MW-1U, however, there are too few samplings after ash placement to assess whether significant changes in overall concentrations of calcium and magnesium are occurring after the baseline period. On their face, the three measurements of calcium after ash placement suggest that if the ash is adding calcium to the system, it is leaving the site faster than it is being liberated from the ash.

baseline monitoring period at <0.0230 mg/L and <0.0100 mg/L respectively. Arsenic levels at this monitoring point were already high during the baseline monitoring period. A very high level of arsenic, 0.9180 mg/L, was measured in January 1996, 4-6 times higher than all other baseline concentrations and reportedly measured just before the mining and ash placement operation began. However in March 1999, three years into ash placement, arsenic sharply increases to 3.89 mg/L, 389 times higher than the DWS of 0.01 mg/L (effective January 23, 2006), and 78 times higher than the former DWS. This increase appears to be a result of contamination from the ash and is so high that it masks the high levels of other trace elements. Cadmium rises from 1-3 times its DWS in baseline measurements to 8 times its DWS in 1998 and 46 times its DWS in 1999. Selenium is below detection limit during baseline monitoring and then rises to more than 6 times its DWS in 1997 and more than 3 times the standard in 1999. Lead concentrations are 6-7 times the detection limit measured in baseline monitoring in March 1997 and March 1999.



The table below illustrates the trace metal concentrations at MW-2D after mining and ash placement began along with the DWS (federal MCL) for these metals. The 1997 measurement for cadmium and the 1998 measurement for lead were below detection limits.

	MCL Mg/L	1997 mg/L	1997 X MCL	1998 mg/L	1998 X MCL	1999 mg/L	1999 X MCL
Arsenic	0.010*	1.095	109.5 X	0.119	11.9 X	3.89	389 X
Cadmium	0.005	<0.03	6 X	0.04	8 X	0.23	46 X
Lead	0.015	0.063	4.2 X	<0.005	Below MCL	0.069	4.6 X
Selenium	0.05	0.334	6.68 X	0.024	Below MCL	0.177	3.54 X

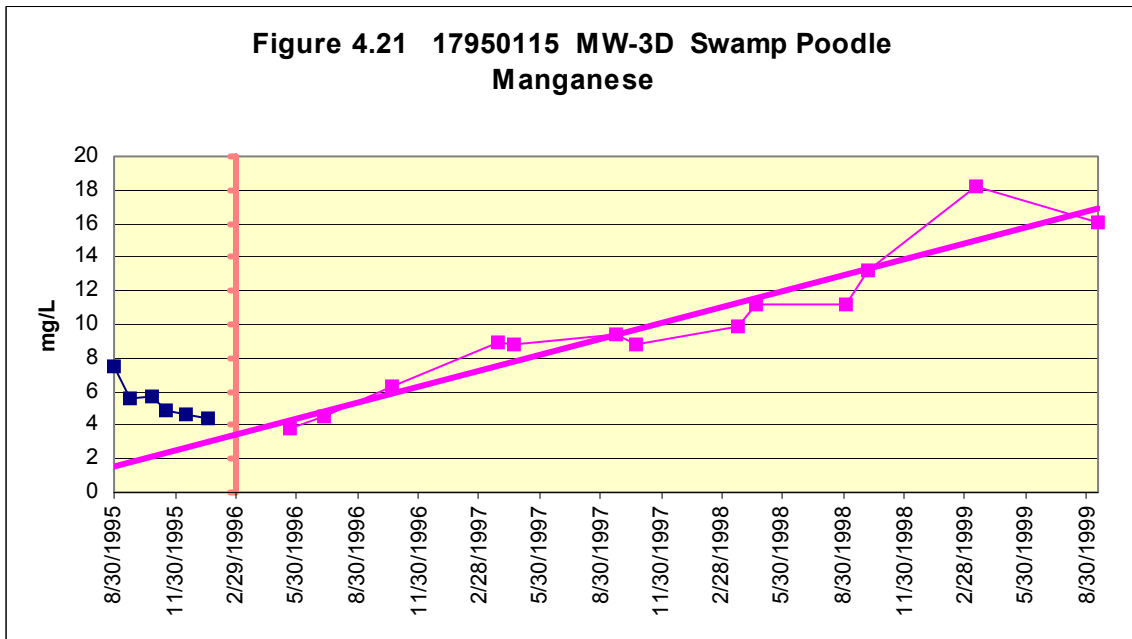
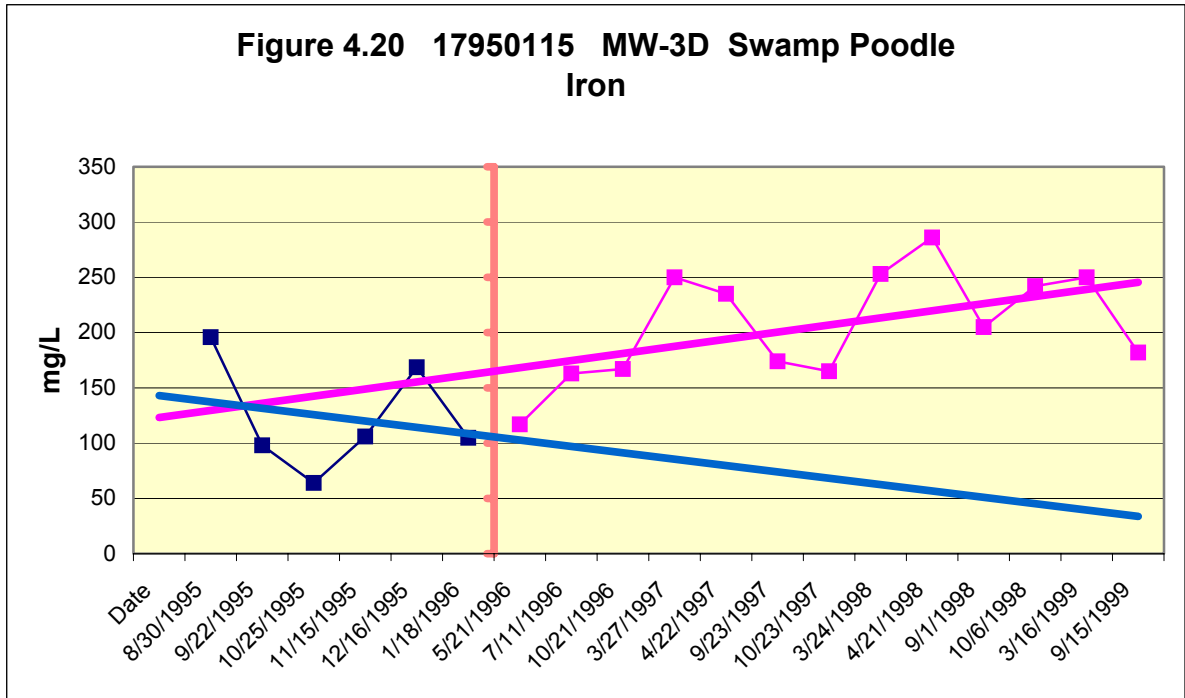
effective 1/23/06

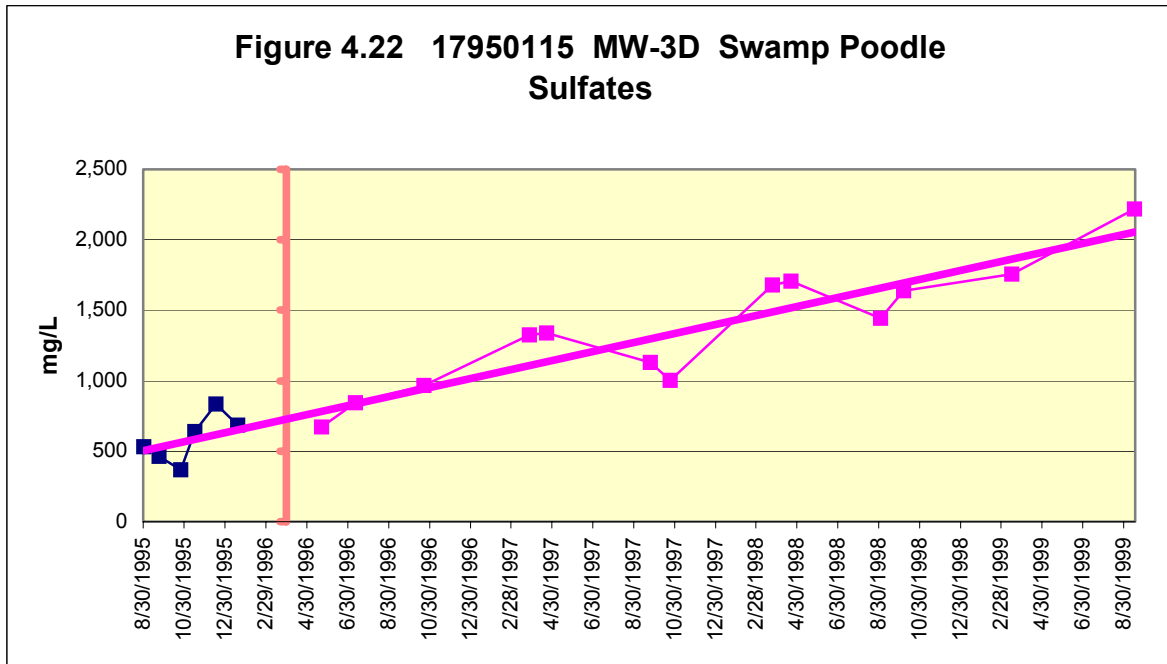
In the above chart, the first column designates the trace metal, and the second column contains the DWS concentrations (Maximum Contaminant Level) for each element. The third column contains the measured concentrations for each element at MW-2D for the year 1997, and the fourth column is the factor that the measured concentration exceeds the MCL value. For example, the MCL for arsenic (effective 1/23/06) is 0.01 mg/L; the measured amount recorded in 1997 at MW-2D was 1.095 mg/L. The number of times the measured amount exceeds the MCL is displayed in column four. A number followed by an “X” means that this is the factor by which the MCL is exceeded. For the arsenic example in 1997, the value is 109.5 X. This means that the arsenic number recorded from MW-2D in 1997 is 109.5 *times* the MCL value. The columns for 1998 and 1999 data were calculated in the same fashion as for 1997.

The fact that only annual sampling for trace metals was undertaken after ash placement began hampers assessment of the causes of these elevated levels of trace elements, although such levels are not unusual at downgradient sampling points around non-mine coal ash disposal facilities. Their occurrence simultaneously with the sharp drop in acidity, sulfate and TDS at MW-2D is of note. These levels of trace elements decisively underscore why more than three years of monitoring much less monitoring only once each year is needed for trace elements at mine coal ash placement sites.

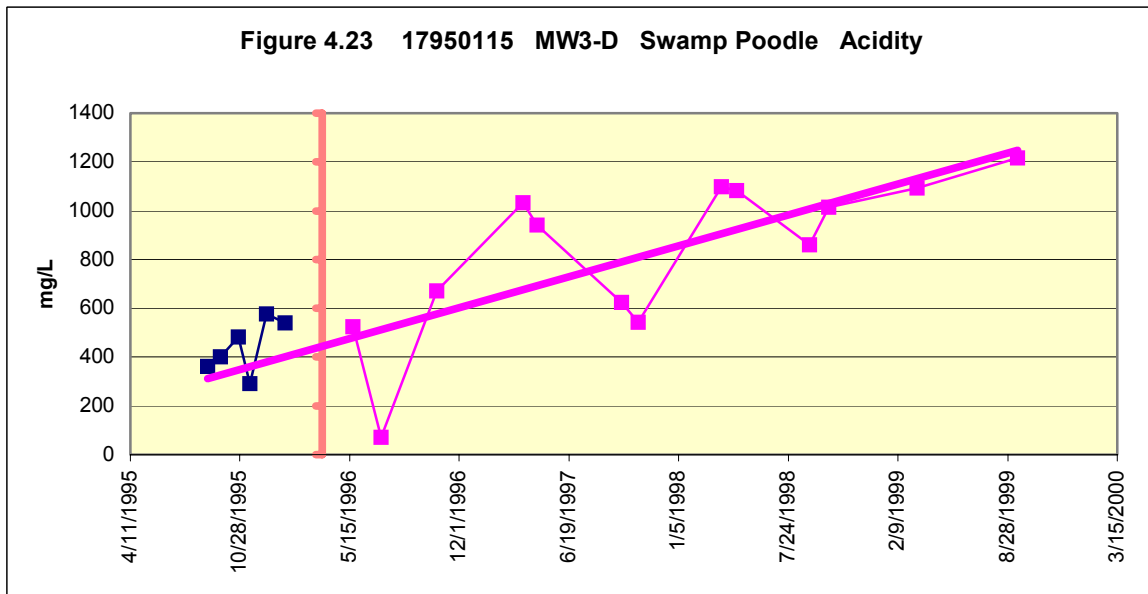
MW-3D

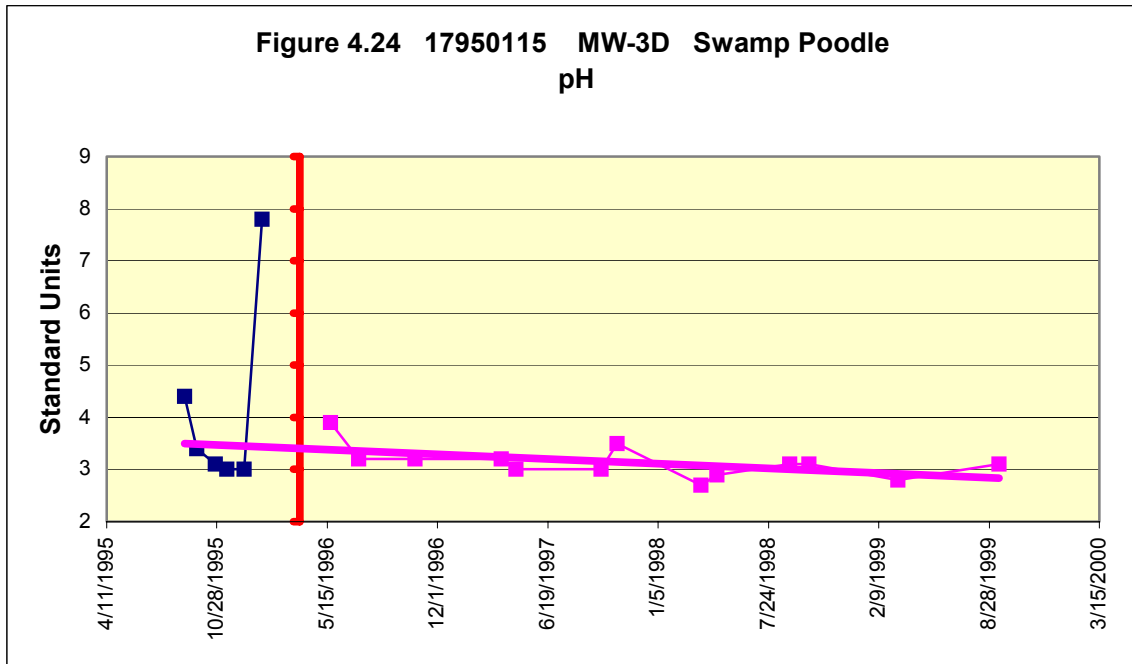
The major element graphs for MW-3D (figures 4.20, 4.21, and 4.22) show lower values than MW-2D, but the trends more clearly indicate degradation. Iron, manganese, and sulfates have increasing concentrations over time. In the case of manganese (figure 4.21) and sulfates (figure 4.22), the groundwater was degraded substantially beyond the poor water quality shown in baseline measurements. The iron and manganese values rose to many times over the DWS, while the sulfates rose from twice to over 8 times the DWS. These values reflect the diluted mine pool water being sampled at this well whereas undiluted mine pool water was monitored at MW-2D, as indicated in the permit text.

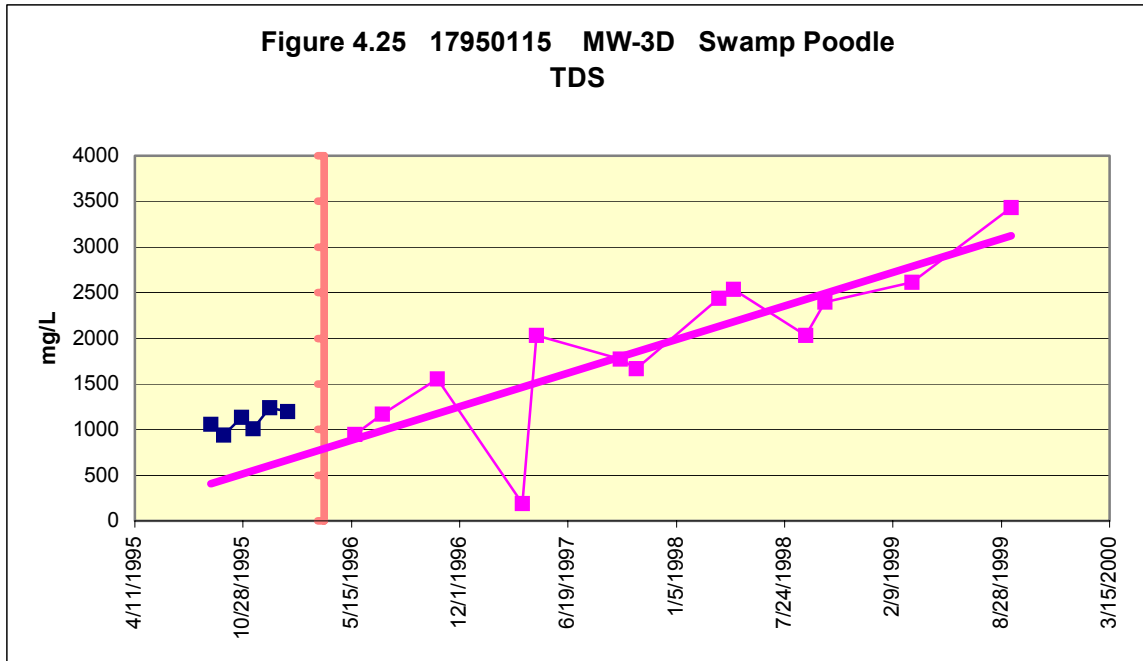




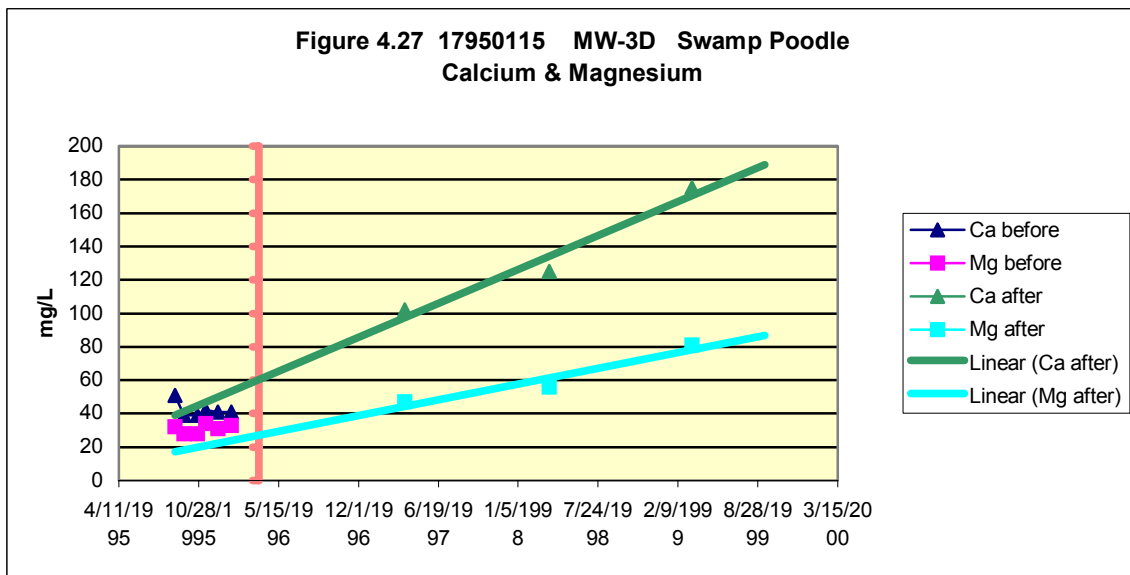
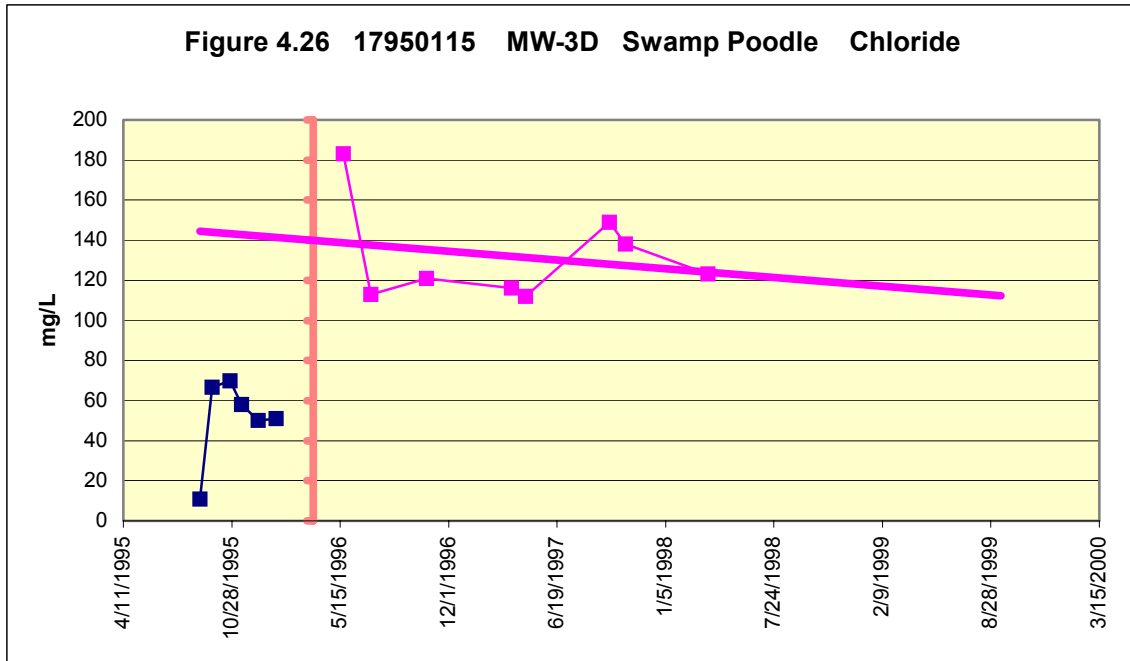
Acidity has a strong upward trend (figure 4.23) at MW-3D along with TDS (figure 4.25), which increases by nearly 3 times from baseline levels during the three-year monitoring period while ash placement occurred. These values are probably dominated by the sulfate input. The average field pH dropped by about a half unit over this three year period (figure 4.24) from 3.5 to below 3, despite a large “spike” to 7.8 in January 1996, and the alkalinity was below detection limits except for the first baseline reading of 4 mg/L.





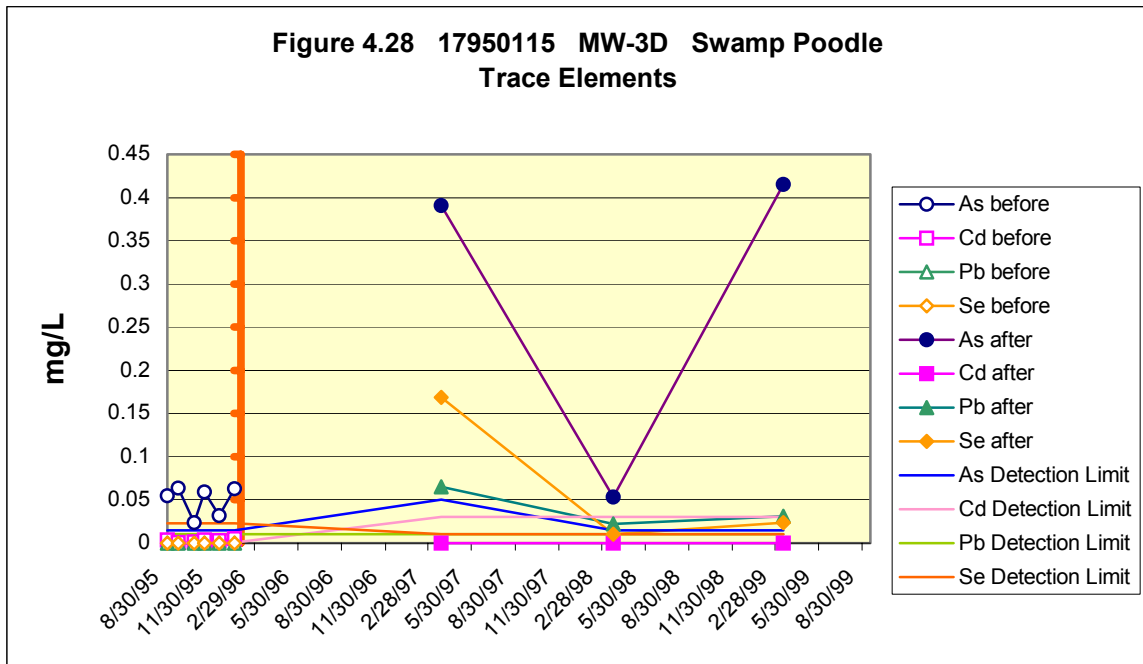


The chloride concentrations (figure 4.26) at MW-3D had a negative trend with average values falling from 140 mg/L to 115 mg/L. However concentrations during ash placement were approximately twice the concentrations before ash placement started. The calcium and magnesium (figure 4.27) had positive trends, probably due to ash leachate. The calcium rose from 100 mg/L to 175 mg/L after baseline measurements. As stated previously, more than three measurements over a three year period of ash indicator parameters such as calcium, magnesium, and trace metals are needed to gain a more firm understanding of trends in their levels at any site. Still one would expect to see higher concentrations of ash parameters in water downgradient of the ash when ash constituents are being mobilized in that water.



The trace elements, arsenic, cadmium, lead, and selenium, are graphed in figure 4.28 for MW-3D. As was the case at MW-2D, measured concentrations for each of these elements are notably higher after ash placement than during the baseline monitoring period. While 4 of the 6 baseline measurements for arsenic exceeded the DWS, arsenic exceeded the highest of these baseline concentrations by more than six times in March 1997 (at 0.391 mg/L) and March 1999 (at 0.415 mg/L). Baseline selenium and lead values represent instrument detection levels of 0.023 and 0.01 mg/L respectively. Actual measured concentrations of selenium during the ash placement period reach 7.3 times the

baseline detection level in March 1997 (at 0.169 mg/L), and lead concentrations exceed baseline detection levels by 2.2 to 6.5 times. Post ash placement cadmium values are below a detection level of <0.03 mg/L, which is six times the DWS and 7.5 to 30 times higher than actual concentrations of cadmium measured during the baseline period. Thus a high detection level does not allow one to discern if the water at MW-3D is being contaminated with cadmium at levels that would make the water harmful for people to consume. The maximum values for these trace elements, while substantially higher than baseline values, drinking water standards and most concentrations measured at upgradient MW-1U, are still lower than the maximum concentrations measured at MW-2D after ash placement began.



The chart below summarizes the factors by which the concentration levels at MW-3D exceed the DWS after mining and ash placement begin. The exception is cadmium values which were reported at below a detection limit of <0.030 mg/L during the ash placement period. These numbers are presented and calculated in the same manner as those in the chart for the MW-2D trace elements.

	MCL mg/L	1997 mg/L	1997 X MCL	1998 mg/L	1998 X MCL	1999 mg/L	1999 X MCL
Arsenic	0.010*	0.391	39 X	0.053	5.3 X	0.415	41.5 X
Cadmium	0.005	<0.03		<0.03		<0.03	
Lead	0.015	0.065	4.3 X	0.022	1.4 X	0.031	2.1 X
Selenium	0.05	0.169	3.38 X	0.010	Below MCL	0.024	Below MCL

* effective January 23, 2006

MW-4D

MW-4D is located southwest of MW-3D (see map) and is one of the three downgradient ash monitoring wells on the site.

The iron concentrations at MW-4D (figure 4.29) show a decreasing trend after ash placement. The first iron measurement, at 78 mg/L, is about the same as the average baseline value; then a rise to 176 mg/L in the summer of 1996 before iron concentrations decline to slightly above to well below baseline levels in 1997 and late 1998. This trend is opposite that of iron at MW-3D. The manganese concentrations are plotted in figure 4.30, and show a rising trend after baseline monitoring. This trend is similar to that at MW-3D, but the values at MW-4D are not quite as high. The sulfates also show levels that exceed baseline levels and a rising trend (figure 4.31) after mining and ash placement start similar to MW-3D, but also with lesser average values.

Acidity increases over time at MW-4D (figure 4.32), but the highest average concentrations represented by the trendline rise at most about 70 mg/L above baseline values. Usually, the sulfates contribute most heavily to acidity, but the sulfate trend average rises nearly 500 mg/L above baseline; some element(s) in the groundwater at MW-4D appear to be buffering acidity to some extent.

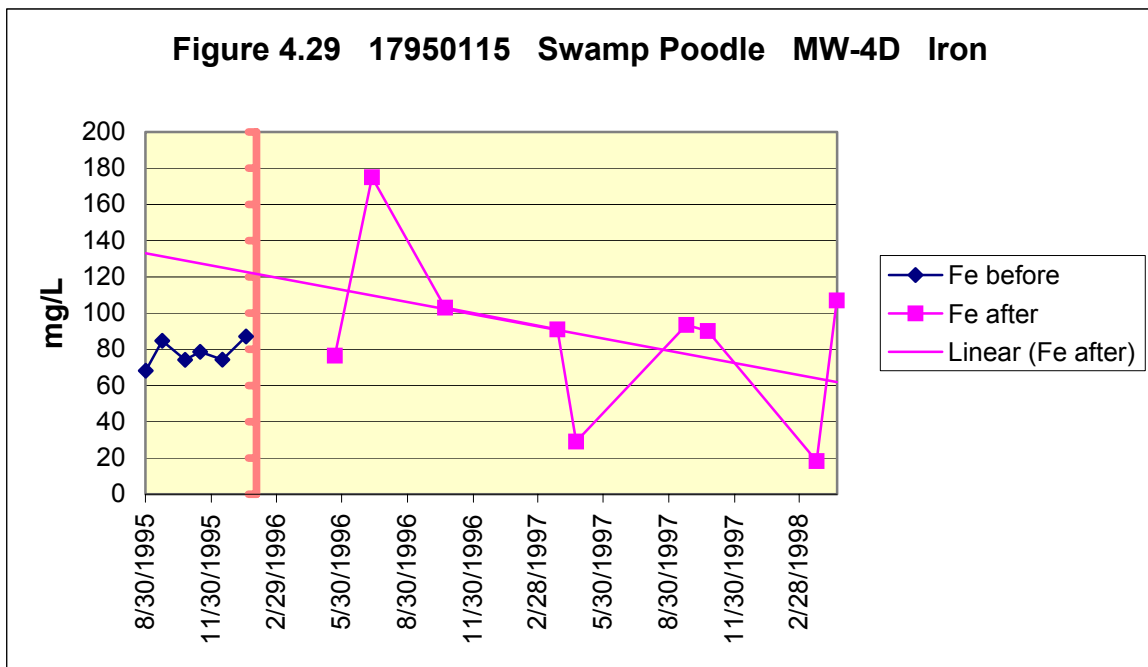
The field pH (figure 4.33) shows a downward average trend, from an average value of 3.7 down to about 2.8. These pH numbers represent a very acidic groundwater environment, and the trends and values for pH at MW-4D are similar for those at MW-3D and MW-2D.

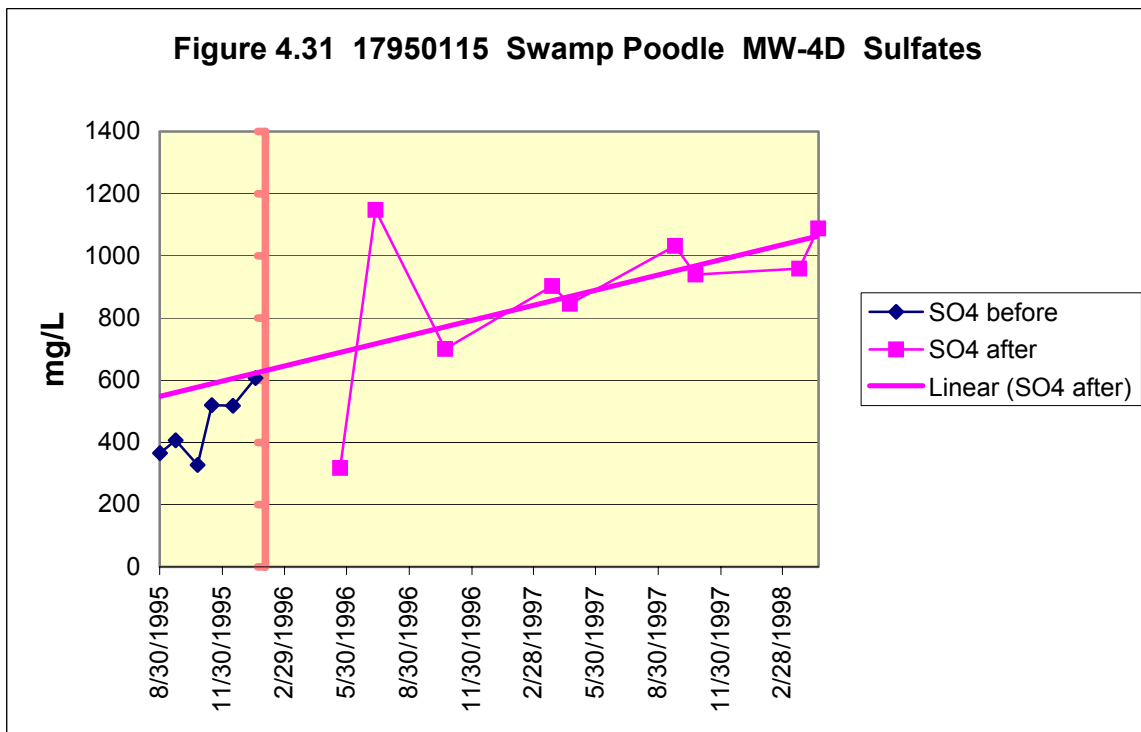
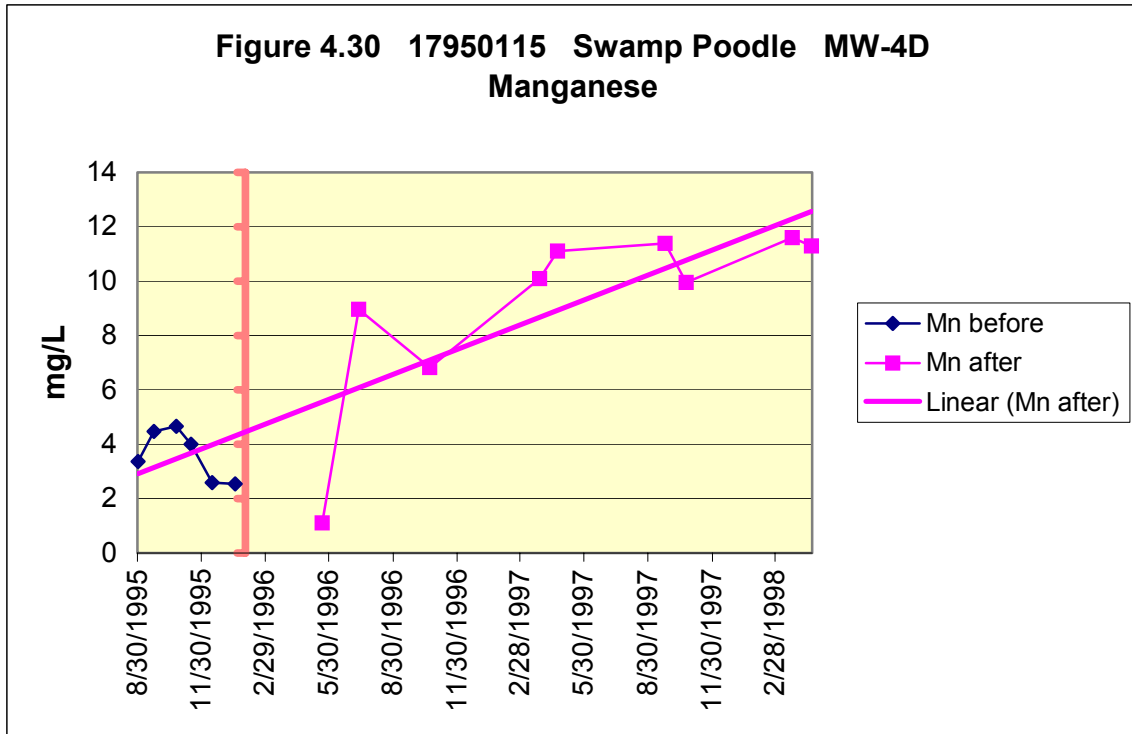
The plot for TDS (Total Dissolved Solids) (figure 4.34) is almost identical to that of sulfates for MW-4D, except that the average TDS values are about 225 mg/L higher than the sulfate concentrations. As the graph curves have very close shape relationships, the TDS behavior is probably controlled chiefly by the sulfate concentrations.

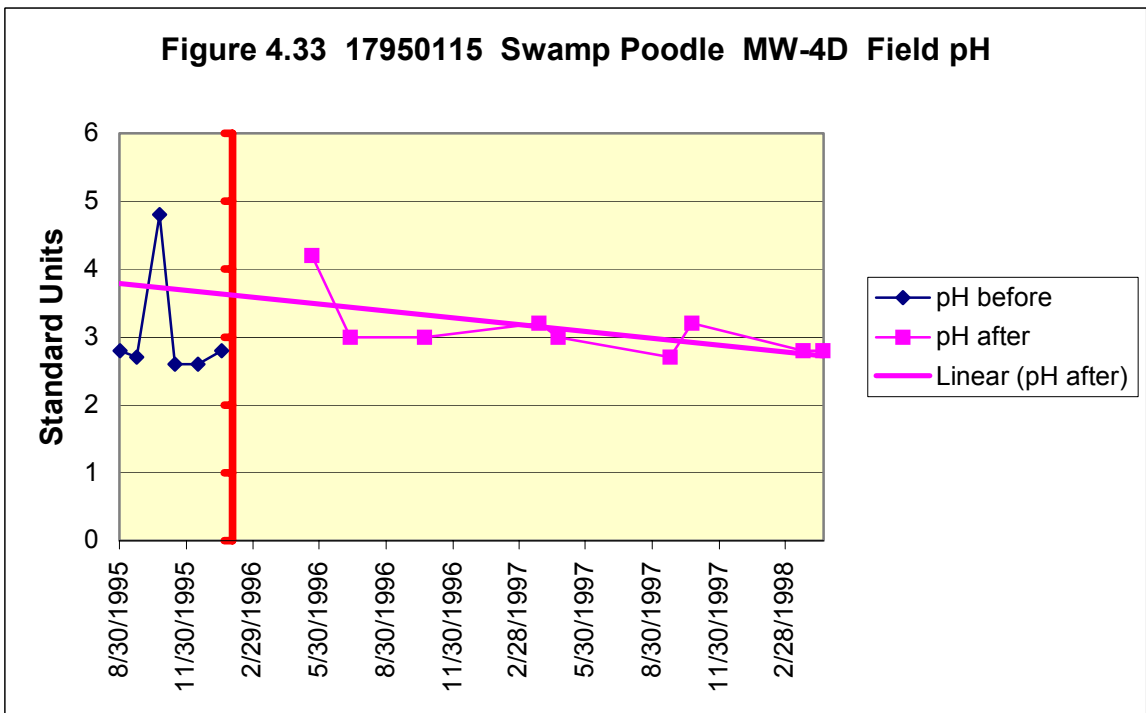
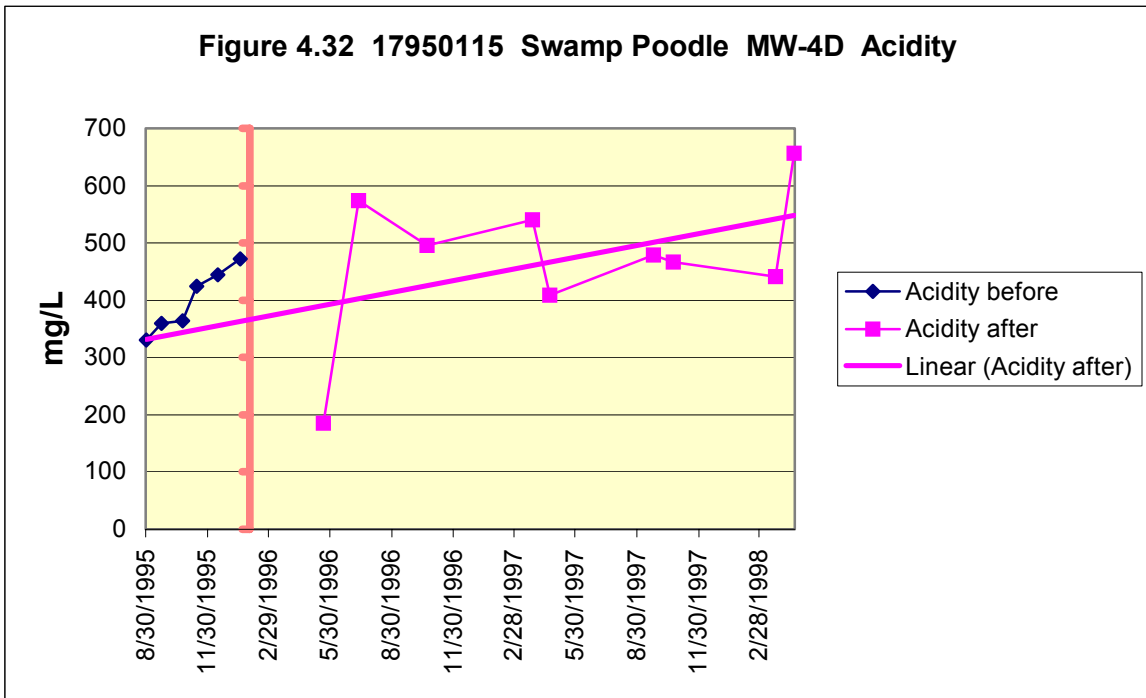
Figure 4.35 illustrates the chloride concentrations over time, and shows a slightly decreasing average trend. All of the values, except for the 310 mg/L peak in June 1996, are below the highest baseline point of 280 mg/L. This high level of chloride relative to

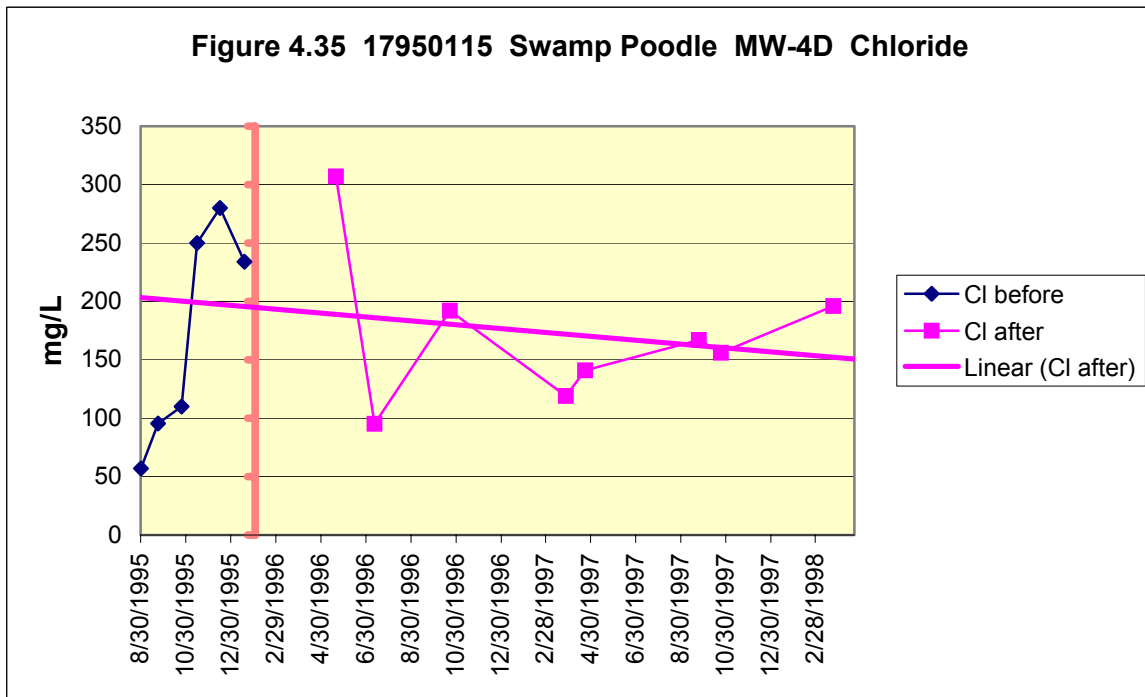
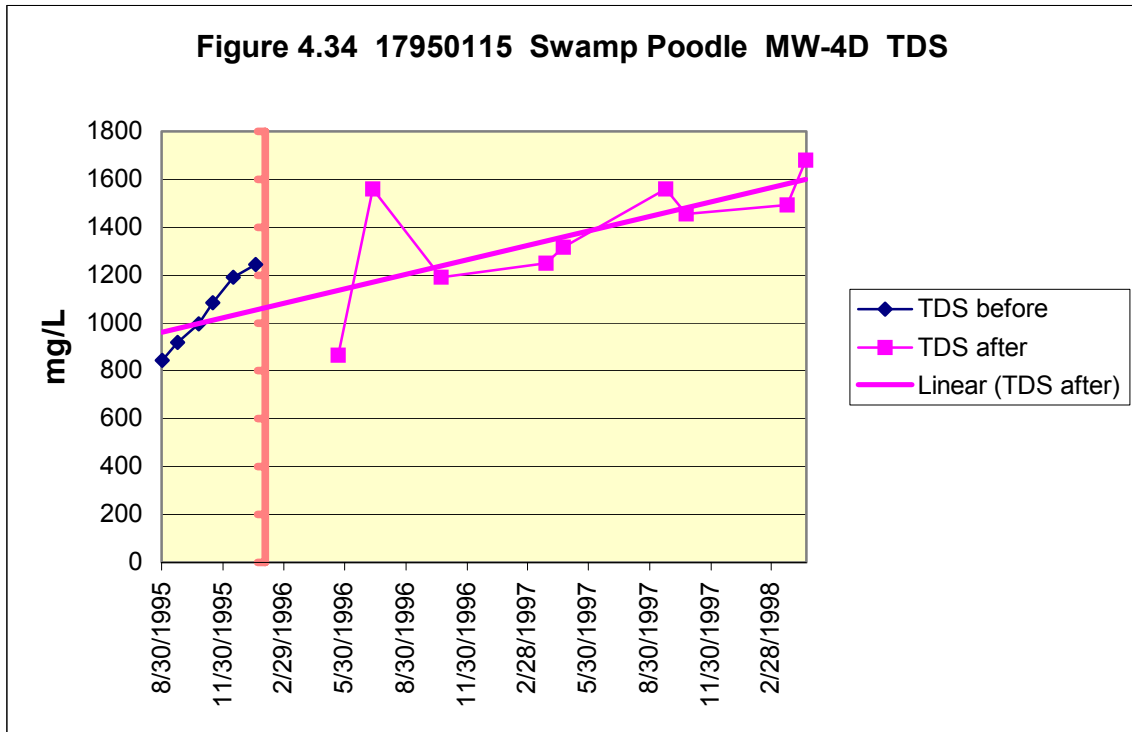
levels seen at most other sites studied in this project as well as the influx of chloride in June 1996 is probably due to road salt contamination, from the proximity of State Route 53 to MW-4D; the edge of the highway is less than 100 feet from the well.

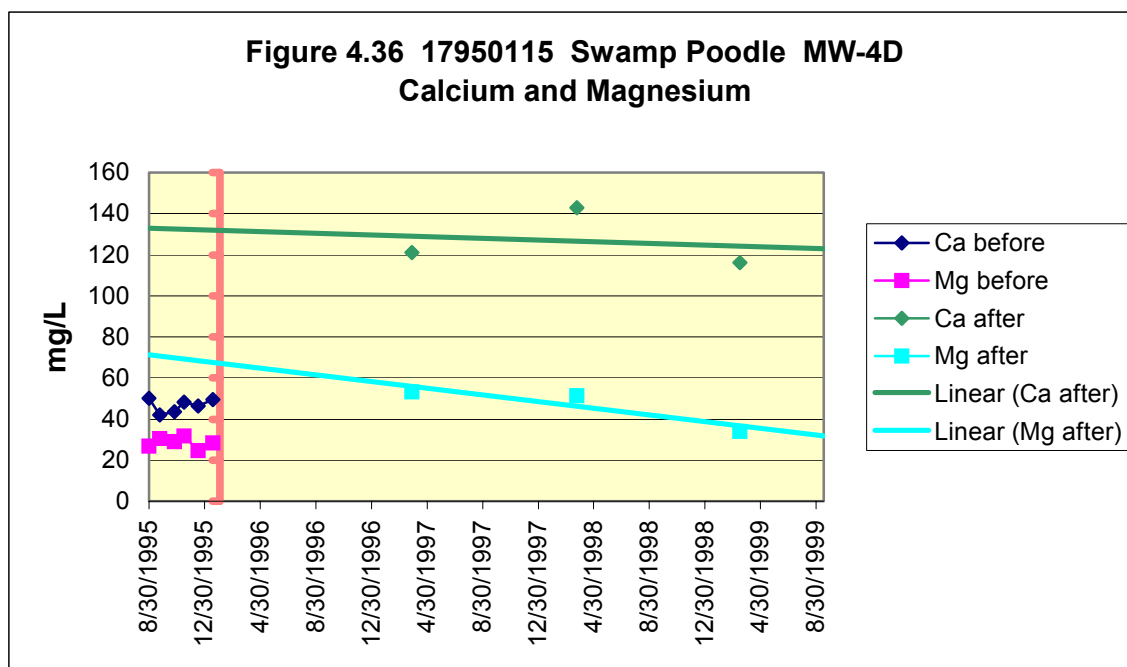
The calcium and magnesium values and trends for MW-4D are shown in figure 4.36. This graph illustrates the usual six baseline points, and just three yearly monitoring results provided for ash parameters at the Swamp Poodle site. The calcium trend is increasing, with values well above baseline concentrations, showing that ash probably contributed much of this calcium. The magnesium trend is very slightly downward, but there is still a significant jump in magnesium concentrations above baseline values, indicating a fast change in the groundwater chemistry after ash placement.











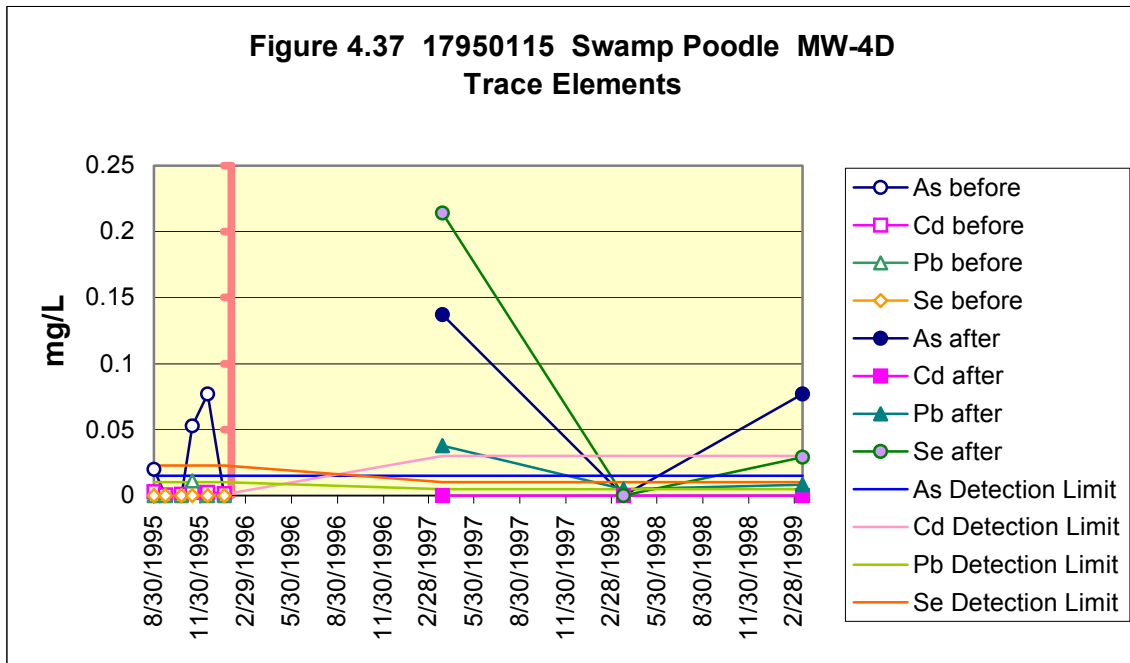
The trace elements arsenic, cadmium, lead, and selenium are plotted in figure 4.37. As has been the case at the other downgradient wells, measured concentrations are notably higher after ash placement than during the baseline monitoring period. The highest concentrations of arsenic, lead and selenium measured at MW-4D occur during the first sampling event in the ash placement period (March 1997), a year and two months after ash shipments first arrived. At 0.137 mg/L arsenic is nearly twice the highest baseline level (0.077 mg/L), almost 14 times the DWS and nearly 3 times the former DWS. Lead is measured at 0.038, nearly four times baseline detection levels and almost 3 times the DWS. Selenium was measured at 0.214 mg/L in March 1997, more than 9 times higher than baseline detection levels, more than 4 times the DWS and higher than the highest selenium concentration at MW-3D, 0.169 mg/L also in March 1997. However, unlike MW-2D and MW-3D, measurements for these trace elements at MW-4D in 1998 and 1999 were not above baseline concentrations. An exception was selenium which was measured at 0.029 mg/L in the March 1999 sampling while all baseline measurements were <0.0230 mg/L.

Values recorded during the baseline monitoring at MW-4D were usually below instrument detection levels of <0.015 mg/L for arsenic, <0.0100 mg/L for lead and 0.0230 mg/L for selenium. In contrast, as occurred at MW-3D, actual measurements of cadmium concentrations during the baseline monitoring at MW-4D were replaced during the ash placement period with measurements below detection limits of <0.30 mg/L in 1997 and <0.03 mg/L in 1998 and 1999. These are 11 to 600 times above the actual baseline concentrations and 6 to 60 times over the DWS, making it impossible to know

whether concentrations of cadmium have been rising to harmful levels from this monitoring.

While concentrations of trace elements at MW-4D are higher than concentrations at the upgradient MW-1U, they are significantly lower than concentrations at MW-2D and, with the exception of selenium, somewhat lower than concentrations at MW-3D. This may reflect the location of MW-4D at a point more isolated from ash than the other two downgradient points.

The higher concentrations of arsenic and selenium at MW-4D in March 1997 nonetheless suggest the ash is contributing these trace metals to the groundwater. However as also occurred at the other monitoring points (including MW-1U), concentrations of these trace elements dropped substantially in most instances in March 1998 at MW-4D. Either the direction of water flow shifted or slackened from the source(s) of contamination, dilution from inflows to these monitoring points occurred or these trace elements in the ash or surrounding mine materials tended to remain more insoluble in a very acidic groundwater environment. In 1999 however most of the trace metal concentrations at MW-4D increased again similar to the pattern at other monitoring points, again possibly reflecting changes in the flow regime or ash placement operations at the site.



Conclusion

Further study is warranted for this site, as the ash placement appears to be contaminating groundwater and adding to the degradation caused by mining at the site. This is indicated most clearly by the higher concentrations after ash placement of arsenic, cadmium, selenium, lead, chloride, and manganese at downgradient monitoring well MW-2D and higher concentrations of arsenic, selenium, lead, chloride, and manganese as well as calcium and magnesium at downgradient monitoring well MW-3D after ash placement. Similar higher concentration trends in manganese, sulfate, calcium and TDS are seen at downgradient monitoring well MW-4D during the period of ash placement but with lower or slightly lower average values..

Steadily rising levels of sulfate and TDS at MW-3D and MW-4D appear to correlate with rising acidity at these points from mining but still could reflect the release of sulfate and other constituents of ash due to that acidity. The amount of ash placed, 214,000 tons, was not enough to neutralize the severe AMD, as evidenced by very high sulfate and acidity levels and further supported by already low pH values that fell slightly during placement. The ash and possibly other mining reclamation activities do appear to have caused a significant decline in acidity at MW-2D.

There are three potential sources for water contamination at the Swamp Poodle site; (1) the water in the abandoned underground workings of the Lower Kittanning Coal, commonly referred to as the “mine pool” water; (2) contamination from the mining operation; and (3) contamination from the placed ash. Using the data from the four selected monitoring wells, the sources of the water degradation can be distinguished to some degree.

MW-1U clearly represents upgradient mine pool water that has not been greatly affected by the strip mining operations or ash placement under this permit, although its water quality does appear to be somewhat impacted from previous mining at its location. The water flows underground from this well toward the strip mine-ash placement operation authorized under this permit. Thus the data from MW-1U demonstrates the contribution the mine pool would be making to rising contaminant levels at the downgradient points. This mine pool water is still degraded as many of the concentrations measured for major elements and some of the concentrations for trace elements at MW-1U are well above DWS. However, with the exception of chloride, the overall concentrations of these elements are lower than the concentrations at MW-2D, MW-3D, and MW-4D.

Ash leachate trends are often suggested by significant rises in calcium, magnesium and chloride in downgradient monitoring points. However, chloride rises in MW-1U to the highest levels seen in all of the wells. Statements in the permit file

indicating that road salt is the source of elevated chloride levels are plausible given the vicinity of an interstate, an exit exchange onto the interstate and a state highway on the immediate perimeter of the permit area as well as the timing of high chloride levels being measured in the winter through late spring when residues from road salts might still be washing from soils and entering fluctuating water tables and the mine pool underneath the site. Still, notwithstanding this evidence as well as the acidic conditions that overshadow these elements, rising concentrations of calcium, magnesium and chloride are clearly discernable at MW-3D after ash placement started. MW-4D also shows noticeably higher calcium concentrations and magnesium concentrations that are higher than levels recorded in baseline monitoring.

Further degradation from ash is suggested by trace element concentrations that are substantially higher in MW-2D and MW-3D than in MW-1U and considerably higher from the baseline period to the ash placement period. Initially the arsenic values from MW-2D are 20 times those from the upgradient mine pool, and arsenic from MW-3D are 10 times upgradient mine pool values. In March 1999 arsenic levels at MW-2D are 205 times higher than arsenic levels in the upgradient mine pool, and arsenic levels in MW-3D are 22 times higher than arsenic levels in the upgradient mine pool. The occurrence of high trace elements coinciding with sharply declining acidity, sulfates, and TDS and declining iron at MW-2D suggests that the coal ash rather than AMD is contributing the trace elements. Clearly if more than three samplings had occurred during the ash placement period, a more definitive analysis of the causes for trace element concentrations would be possible. Nonetheless the concentrations that were sampled revealed levels of arsenic, cadmium, lead and selenium that are usually below or close to drinking water standards at the upgradient monitoring point, MW-1U, compared to levels for these elements that are several to many times over drinking water standards at the downgradient monitoring points, MW-2D and MW-3D. The difference in trace element concentrations was not as sharp at MW-4D where only arsenic and selenium were noticeably above baseline concentrations and concentrations at MW-1U and in only one of the three samplings that took place for trace elements after ash placement began.

Nonetheless the fact that trace element concentrations are substantially higher at the downgradient points after mining and ash placement began than before ash placement, is significant and becomes more notable when one considers that those higher levels were found with fewer measurements spread over a longer period (three measurements over four years after ash placement began as opposed to six measurements over five months before ash placement). This suggests a higher probability that the higher levels after mining and ash placement were indicative of actual trends.

Trace element concentrations are often below the detection limits of the analytical instrument measuring the concentrations for lead and selenium during the baseline monitoring period and for cadmium during the ash placement period. High detection levels for cadmium may be hiding concentrations and trends or patterns that reflect adverse impacts to water quality from this toxic trace element.

In addition to differing concentrations in trace elements, a comparison of trend lines for other contaminants at MW-1U, MW-3D, and MW-4D reveals a flat or decreasing average at MW-1U compared to increasing trends and/or higher concentrations after mining and ash placement are underway at MW-3D and MW-4D. This fact clearly shows that with the exception of chloride that appears to come from upgradient road salt close to MW-1U, the upgradient mine pool water is improving in quality and is not contributing to the degradation of water observed in MW-3D.

The same should apply to distinguishing differences between the impacts of the mining and ash placement at this site. Contaminants such as sulfate, iron, and manganese usually rise sharply during strip mining and then settle down as the site is reclaimed and mine spoil is compacted by natural processes. While the rocks at the Swamp Poodle site produced a lot of AMD when mined, the very large reduction in acidity, sulfate, and TDS measured in MW-2D at the end of monitoring support this model.

However, data from MW-3D and MW-4D do not support this model. In the Swamp Poodle operation, ash placement was contemporaneous with strip mining as the ash was placed in the mined-out benches at the Lower Kittanning Coal level. Unlike MW-2D, the trends in all major elements at MW-3D continue to rise at the conclusion of mining and ash placement, suggesting that the placed ash did not contain sufficient alkalinity to neutralize the strongly acidic conditions and that contaminants from the ash were being mobilized in the reclaimed environment. Many of the major concentrations show similar increases at MW-4D also.

As is the case for most of the permits reviewed in this report, monitoring was stopped prematurely at the conclusion of mining and ash placement. Monitoring, however, should be reinstated and expanded at this site to include: additional monitoring points upgradient, downgradient and in the ash; monitoring for more constituents exclusive to the leachate of ash disposed in this mine; and sampling on at least a quarterly basis for these constituents. These steps will help explain the substantial groundwater degradation from baseline conditions found at the three downgradient monitoring wells.